

James

NO 2

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Nourishment of the Fetus in Utero

The

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DISSERTATION

on the

Nourishment of the Foetus
in Utero:

With some observations on the effects of Utero Gestation
on the Maternal system;

And on

The commencement and effects
of Respiration

DISSERTATION

ON

Nourishment of the Fetus
in Utero:

With some observations on the effects of the
various fluids of the

Fetus

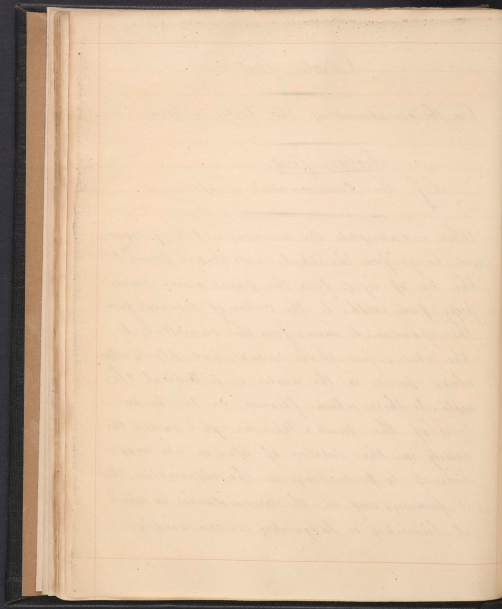
Their composition and effects
of Respiration

Chapter first

On the nourishment of the Fetus in Utero

Section first Of the commencement of life

When we contemplate the numerous orders of organized being, from the short lived vernal plants to the tree of ages; from the plant which scarcely peeps from earth, to the cedar of Lebanon; from the ephemera, to man; from the annulate, to the whale; from those animals and plants which almost perish in the winter of a tropical climate, to those which flourish on the mountains of the North: When we reflect on all the variety in the duration of life; in the magnitude of its productions; in the organization that it produces; and in the circumstances in which it flourishes or languishes, we can hardly

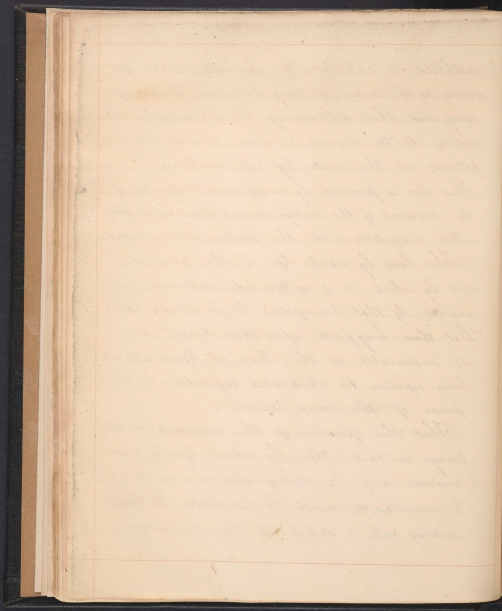


withhold to subscribe to the idea, that life varies as the orders of being to which it belongs vary, and that determining the organization according to the variety, it thus secures the perpetuity of the order by reproduction.

That life is produced by an appropriate operation of the rudiments of the embryo on each other, is a proposition compatible with the common sense of man.

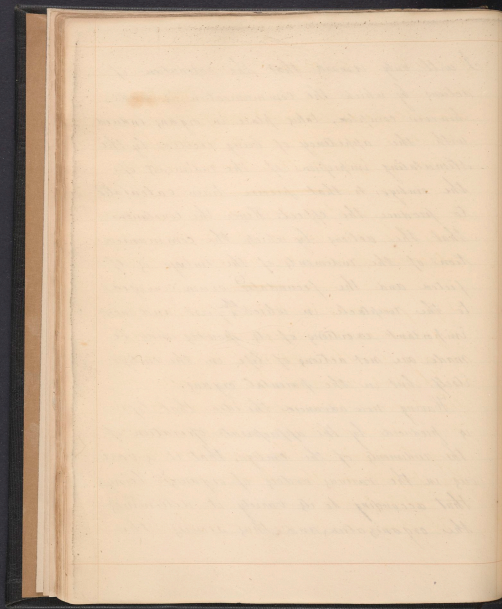
The laws by which life is thus produced, and by which it is afterwards continued, being enacted by that Omnipotent Word which said: "Let them begeth after their kind," are as immutable as the laws of light, attraction, repulsion &c which were originated by the power of the same Word.

That the operation of the rudiments of the embryo on each other by which life is commenced may be appropriated a variety of circumstances must be favorable. Without entering into a detail of those circumstances



I will only remark that the calculation of actions by which the communication is made, however complex, takes place in organs endowed with the aptitude of being excited by the stimulating impression of the rudiments of the embryo, to that precise train calculated to produce the effect. Hence the conclusion that the actions by which the communication of the rudiments of the embryo is effected and the fecundatio ovum conveyed to the receptacle in which ^{the} first and most important exertions of its powers may be made, are not actions of life in the embryo itself, but in the parental organs.

Having now advanced the idea that life is produced by the appropriate operation of the rudiments of the embryo; that it is various in the various orders of organized beings; that according to its variety it determines the organization, and thus secures the



perpetuity of the order by reproduction, and that the actions by which life is both produced and afterwards continued are governed by immutable laws, I proceed to consider the first actions of life in the human embryo.

Section Second

Of the establishment of a connection and intercourse between the human embryo & mother

Life first manifests itself in the powers of organization, and of acquiring those principles necessary for the support of its own actions.

The first actions of life are excited in the production of an organ through the medium of which, those necessary principles may be acquired. The organ produced for this purpose in the human embryo is the umbilical vein.

The principles to be acquired I will

toom the nutritive principles without having regard at present to the source whence they are originally derived.

Without a supply of the nutritive principles vitality cannot continue its actions.

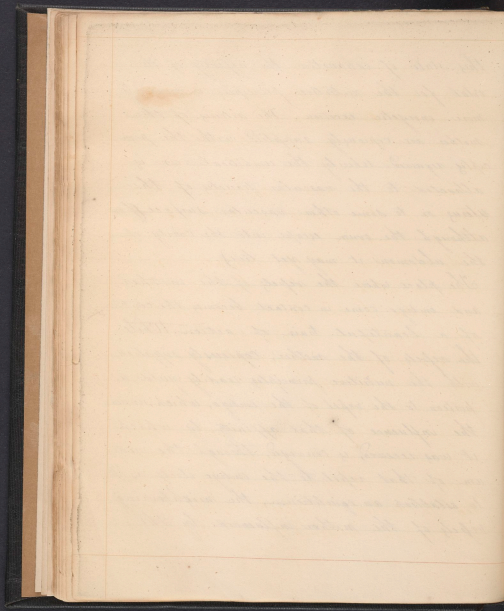
The first actions of life are supported by the nutritive principles secreted in the ovum. In oviparous animals and in the seeds of plants, that secretion is considerable.

I must now assume it as a proposition, that between the vital and nutritive principles, there is a peculiar affinity existing, whereby, through the medium of ~~the medium of~~ the organ produced for the purpose, which in the human embryo is the umbilical vein, a supply may be obtained as follows. The production of the umbilical vein is necessarily attended with some exhaustion of those principles which supported the actions by which it was produced. By

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this state of exhaustion the affinity of the
vital for the nutritive principles is aroused to
more energetic exertion. The arteries of the
mother are copiously supplied with the prin-
ciples required, whereby the umbilical vein is
attracted to the vascular parietes of the
uterus or to some other vascular surface, for
although the crum escape into the cavity of
the abdomen it may yet live.

The place where the vessels of the mother
and embryo come in contact becomes the centre
of a beautiful train of action. While
the vessels of the mother, copiously supplied
with the nutritive principles, readily yield a
portion to the vessel of the embryo, which, under
the influence of that affinity by which
it was secured, is conveyed, through the medi-
um of that vessel to the embryo itself, as if
to establish an equilibrium, the neighbouring
vessels of the mother influenced by the

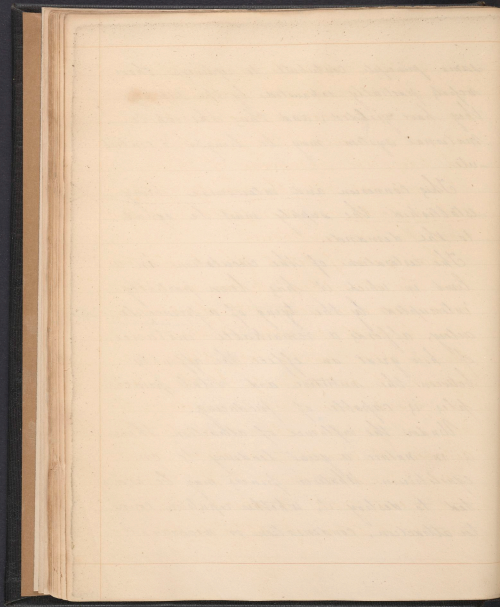


same principle contribute to replenish those vessels partially exhausted by the supply they have yielded; and thus the whole maternal system may be brought to combat - etc.

This connexion and intercourse being established the supply must be equal to the demands.

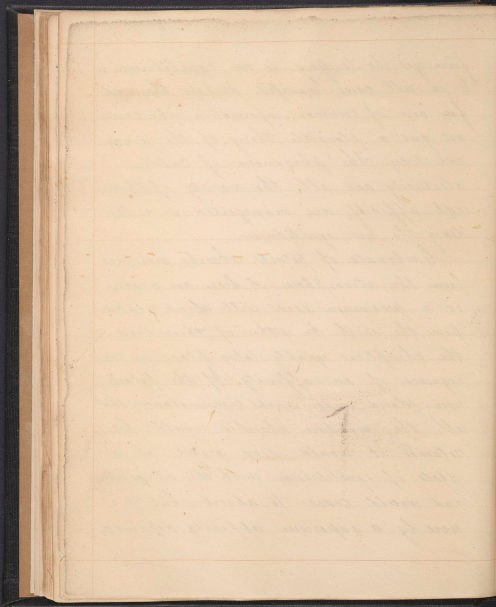
The restoration of the circulation in a limb in which it has been partially interrupted by the tying of a principle artery, affords a remarkable instance, of how great an effect the affinity between the nutritive and vital principles is capable of producing.

Under the influence of attraction there is in nature a great tendency to an equilibrium. Whatever power may be exerted to destroy it, whether repulsion, counter attraction, condensation or mechanical



force, yet the tendency to an equilibrium is in all cases manifest. Perhaps there are few now of common information who cannot give a plausible theory of the winds and tides. The phenomena of Caloric electricity and all the variety of Chemical affinity are manifested in a tendency to an equilibrium.

Carbonate of potash absorbs moisture from the atmosphere. A bean, an acorn, or a persimmon seed will absorb moisture from the earth. In either of those cases the absorption equally takes place in consequence of an affinity. If the potash were placed under such circumstances that all the moisture absorbed would be retained it would soon arrive at a state of equilibrium with the atmosphere and would cease to absorb; but if it were by a superior affinity deprived



of its moisture as fast as absorbed, then the equilibrium could not be formed and the absorption would go on; So, if by the process of vegetation the equilibrium were not constantly destroyed the plant would cease to absorb.

That in the human body the actions of life may destroy the equilibrium and thus excite or increase the affinity for those principles calculated to restore it, is not contrary to reason, and, I think, will by observation be found true. This is the principle hypothesis on which I proceed; but in this limited dissertation I shall not, by any means, be able to show its importance.

While the principle part of the
is supplied, and thereby
the principle of a further

Section third
Of the distribution of the nutritive
supply in the embryo.

Under that attractive influence that we have described as excited by want and as excited to establish an equilibrium, the supply from the mother must tend to that point where the need is greatest. The need must be greatest at the point where the vital action, having commenced, has produced the first exhaustion. The tendency of the nutritive supply being originally towards the principle seat of the sensorium, induces us to believe that there vital action commences.

When the principle seat of the sensorium is supplied, and thereby rendered capable of a farther exertion

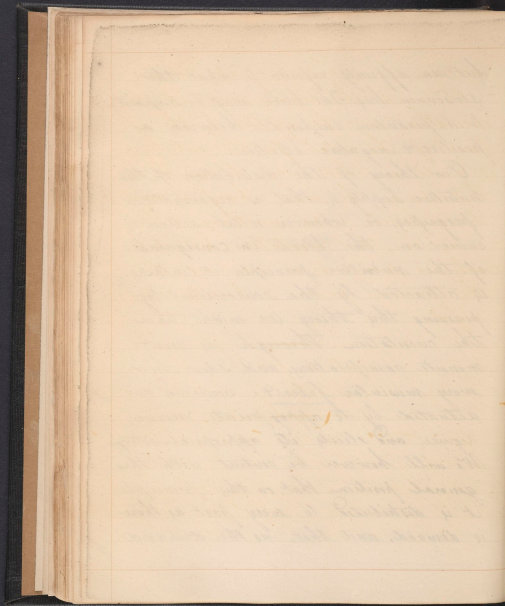
of its power, the demand in the lower portion of the embryo preponderates. The medulla spinalis, by attracting the nutritive supply required, causes it to form ^{the arch of} the aorta, and to descend with itself.

I will here observe, that, I suppose the sensorium endowed with the powers of life manifested in organization, nutrition and growth. Those actions cannot be carried on without a constant consumption of the nutritive principles. This consumption destroys the equilibrium and excites the affinity for a fresh supply.

When affinity exists between two bodies the attraction exerts an equal force on each; but if one be a fluid, it will yield to a force whose impression would hardly be perceived on a solid. The blood is a fluid which has an affinity for the nutritive principles.

but an affinity inferior to what the
sensorium has. The blood may be compared
to a pendulum suspended between a
positive & negative electric.

Our theory of the distribution of the
nutritive supply is, that as organization
progresses, or whenever vital action is
carried on, the blood in consequence
of the nutritive principle it contains
is attracted by the sensorium. By
pursuing this theory we might trace
the circulation through its most
minute ramifications, and show how
every muscular fiber &c. nourished and
actuated by its appropriate nerve
requires and solicits its appropriate artery.
We will however be content with the
general position, that on this principle
it is distributed to every part as there
is demand, and that, as the demand



increases the supply must also increase.

Although the commencement of the circulation may be effected by the affinity of the vital for the nutritive it could in that way be carried on but slowly; the heart therefore must be considered as an auxiliary in carrying on the circulation, but it becomes so powerful an auxiliary, that the primary power is hardly recognized.

Section fourth

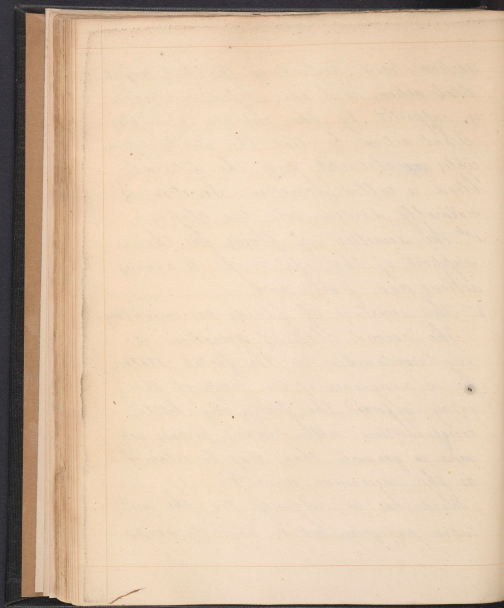
Of the process of nutrition

Our method of accounting for the process of nutrition may be at once apprehended from what precedes; but we would hardly feel justified in omitting to appropriate as

sections more particularly to that subject.
vital action, as I have before mentioned,
is supported by the nutritive principles.
That action by which the nutritive prin-
ciples are abstracted from the arterial
blood is called secretion. Secretion is
naturally divided into two classes:
1st the secretion of fluids for the
support of the system in its various
actions and parts, and
2^d the secretion of fluids excrementitious.

The second class of secretion is
very inconsiderable in the foetal state;
for in consequence of the purity of the
supply afforded the foetus, very little
excrementitious matter remains, perhaps not
more in general than may be retained
as the meconium urine &c.

Blood has an affinity for the nu-
tritive principles, but an affinity weaker

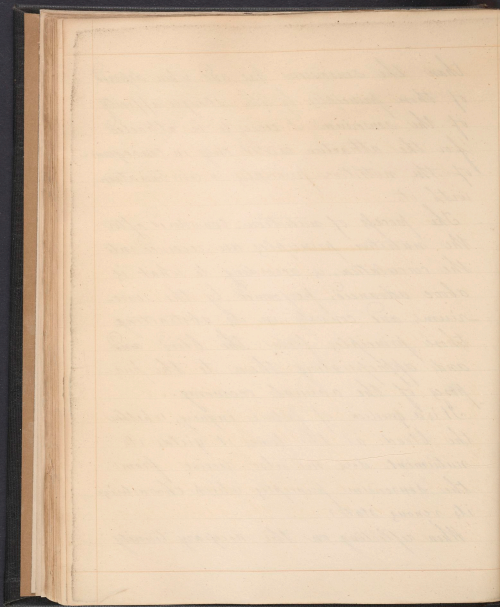


than the sensorium has, and when deprived of those principles by the stronger affinity of the sensorium it ceases to be attracted for the attraction existed only in consequence of the nutritive principles in combination with it.

The process of nutrition, considered after the nutritive principles are received into the circulation, is, according to what is above advanced, performed by the sensorium, and consists in its abstracting those principles from the blood and appropriating them to the purposes of the animal economy.

It is a question of future inquiry, whether the blood at the time it yields its nutriment, does not also receive from the sensorium principles which characterize its venous state.

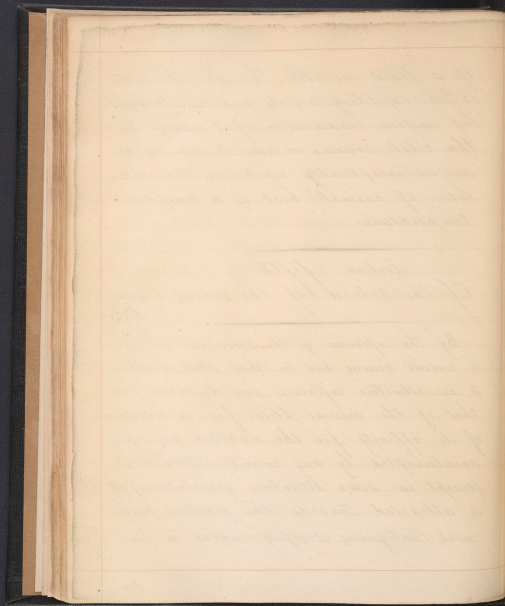
When reflecting on the necessary tenuity



of a fluid secreted through the coats
of the capillary vessels and on the rapid
but uniform condensation of it caused by
the vital action, we cease to view as a
subject inexplicably mysterious, the eva-
lution of animal heat of a uniform
temperature.

Section fifth
Of the return of the venous blood

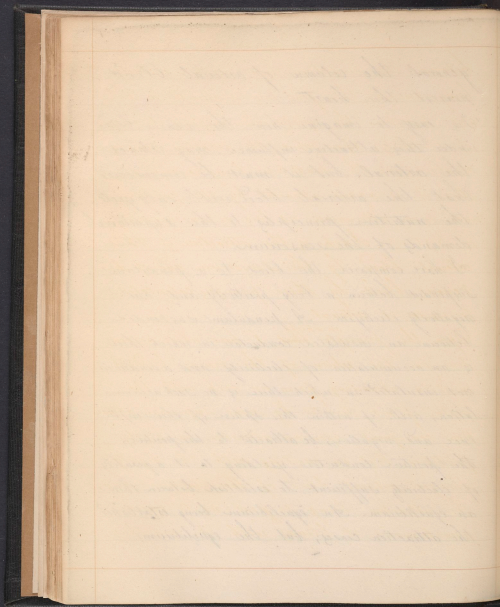
By the influence of the sensorium the blood
is rendered venous and in that state is subject
to an attractive influence very different from
that of the arterial blood; for in consequence
of its affinity for the nutritive principles
uninterrupted by any counter attractions
(except in some situations gravitation) it
is attracted towards the greatest and
most contiguous supply which is in



general the column of arterial blood
nearest the heart.

'Tis easy to imagine how the venous blood
under this attractive influence may retrace
the arterial; but it must be remembered
that the arterial blood will only yield
the nutritive principles to the superior
demands of the sensorium.

I have compared the blood to a pendulum
suspended between a body positively and one
negatively electrified. A pendulum suspended
between an insulated conductor in which there
is an accumulation of electricity, and a conductor
not insulated in which there is no such accumu-
lation will, if within the sphere of their influ-
ence and negative, be attracted to the positive;
the positive conductor yielding to it a quantity
of electricity sufficient to establish between them
an equilibrium. An equilibrium being established
the attraction ceases; but the equilibrium



between the pendulum and negative conductor being destroyed, the pendulum is attracted to it and to restore the equilibrium imparts its excess of electricity upon which the attraction ceasing as above, and the pendulum being rendered negative, it is again attracted by the positive, and so on alternately as long as an inequality is kept up. Such is the attraction of the arterial blood by the sensorium and of the venous blood by those principles calculated to render it arterial.

Upon the principle ^{on which} that I have above accounted for the return of the venous blood, it must in ascending form an arch with the aorta if not directed by some superior attraction consequent upon an alteration in ^{its} qualities. But on meeting with the highly charged arterial blood of the umbilical vein, the attraction being so great as to cause anastomosis, it blends with it, and thus

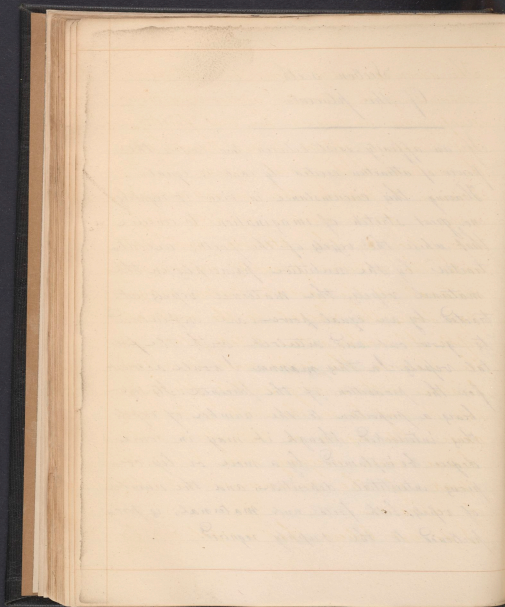
rendered arterial, is no longer influenced by the
arterial blood in the aorta, but follows the es-
tablished course of the supply from the
mother. If the attraction were not sufficient
to cause anastomosing, the venous blood would,
upon our principles, retrace the umbilical
vein to the placenta.

If a portion of the arterial blood of the foetus
(which is less arterial than that in the um-
bilical vein) arrive in the course of the circu-
lation, (as is the case in the hypogastric arte-
ries) at a point where the more highly char-
ged arterial blood passing from the placenta
attracts it with a force superior to that
of the sensuum, but not sufficient to cause
anastomosing, it must traverse it to its source,
upon the principle of the return of the ve-
nous blood.

Section sixth
Of the placenta

If an affinity exist between two bodies the power of attraction excited by each is equal.

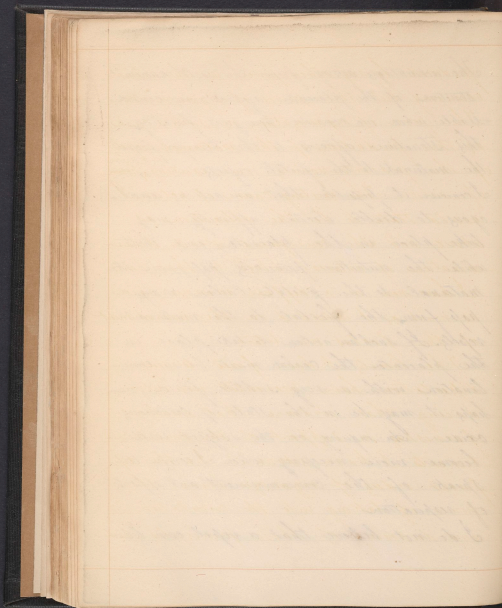
Having this circumstance in view it requires no great stretch of imagination to conceive that while the vessels of the foetus are attracted by the nutritive principles in the maternal vessels, the maternal vessels attracted by an equal power, are influenced to grow out and interlock with the foetal vessels. In this manner I would account for the production of the placenta. Its size bears a proportion to the number of vessels thus interlocked, though it may in some degree be influenced by a more or less copious interstitial depositions and the number of vessels, both foetal and maternal, is proportioned to the supply required.



The advantages arising from the well known structure of the placenta appear very considerable when we consider how great facility this structure affords to the transfer from the maternal to the foetal vessels.

I conceive it possible that an action analogous to double elective affinity may take place in the placenta, and that while the nutritive principles pass from the maternal to the foetal, Carbon may pass from the foetal to the maternal vessels. If such an action do take place in the placenta the carbon must be in combination with a very subtle fluid; perhaps it may be in the state of carbonous oxide. An enquiry on this subject will become more necessary when I come to speak of the commencement and effects of respiration.

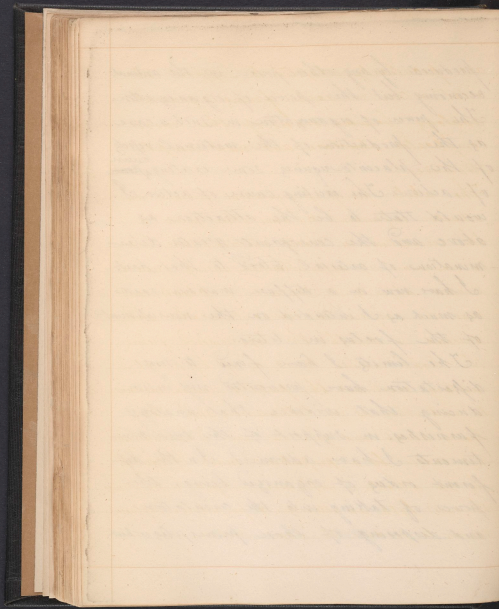
I do not believe that a vessel can be



produced by any other power in the animal economy but the power of organization. The power of organization in such a case as the production of the maternal vessels of the placenta requires some exciting ^{cause} ~~force~~ of action. The exciting cause of action I would state to be the attraction as above and the consequent greater determination of arterial blood to that part.

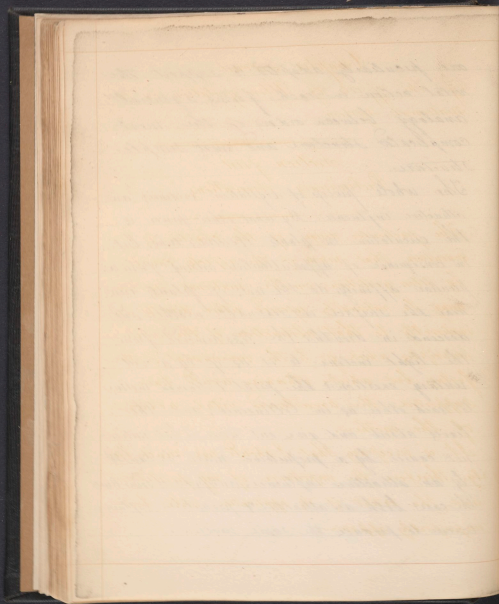
I have now in a diffuse manner said as much as I intended on the nourishment of the foetus in utero.

The limits I have fixed to my dissertation have prevented my introducing that evidence that analogy furnishes in support of the ~~and~~ sentiments I have advanced. In the different orders of organized being, the power of taking into the circulation and disposing of those principles which



are peculiarly adapted to support the vital action in each, forms a general analogy between orders of the most complicated structure and most simple structures.

The whole process of vegetation evidences an attractive influence. By what other power is the circulation in plants effected? Why, but in consequence of attraction arising from a peculiar affinity, do the roots of plants run near the surface in seasonable weather and descend in drouth? the tops removed from the light incline to it as if by a voluntary exertion? the pistil & stamen incline to each other as in *Collinsonia*, and the leaves about and give out air? That motion not caused by a propulsive must be caused by an attractive influence; unless, as is sometimes the case, both an attractive & propulsive influence concur to produce the same motion.

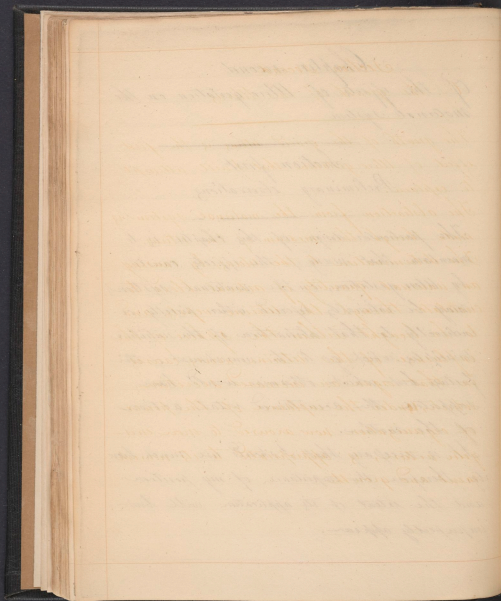


Chapter second Of the effects of Utero-gestation on the maternal system

Section first Preliminary observations

The particular design of this chapter is to maintain that many of the effects, caused, by Utero-gestation, on the maternal system, may be rationally referred either directly or indirectly to that abstraction of the nutritive principles which go to the nourishment of the foetus, but which otherwise would have supported the accustomed vital action of the mother.

It is necessary that I should use much brevity, therefore the importance of my position and the extent of its application will but imperfectly appear.



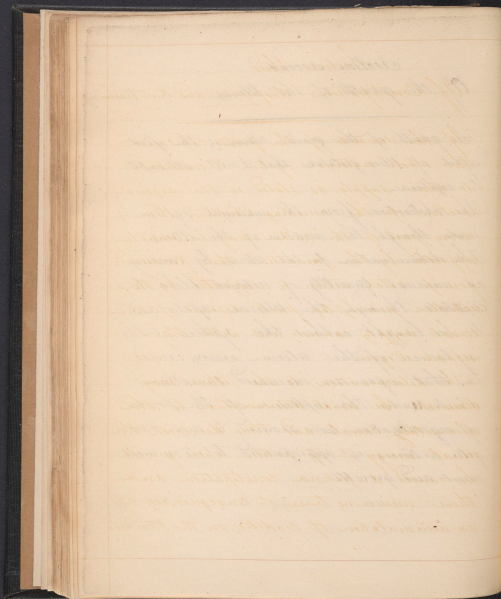
Section Second

Of the growth of the Uterus

The growth of the gravid uterus is the first effect of Utero gestation that I will attempt to explain.

The abstraction from the maternal system is made through the medium of the uterus.

The determination to the uterus, by causing an unusual quantity of arterial blood to circulate through the uterine vessels, and to be brought within the sphere of the influence of the uterine nerves, causes in that organ an increased secretion, which, under the influence of the power of organization now aroused to more energetic action, is appropriated to its nourishment and growth.

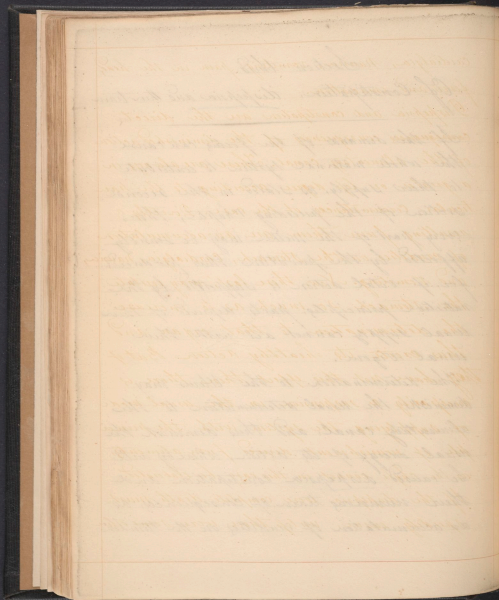


Section third

Of Constipation, dispepsia and their train X

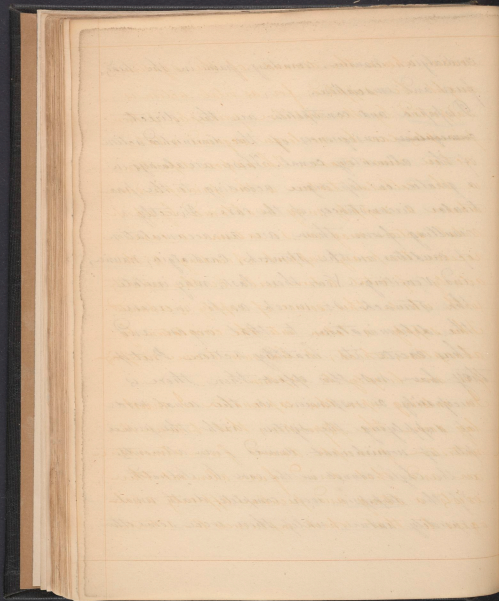
If the demands of the foetus can cause the whole maternal system to contribute to their supply, as stated in the second section of the preceding Chapter, then every part of the mother may be sensibly affected by the privation thus produced for, if vital action is supported by the nutritive principles, parts deprived of their usual supply cannot act with their usual vigour.

The determination to the Uterus may diminish the usual determination to the alimentary canal, and thus diminish the usual energy of its action, whereby will be caused dispepsia constipation and their numerous train of consequences, as an accumulation of cruditiey on the stomach



cardialgia, nausea, vomiting, pain in the head,
fever and emaciation.

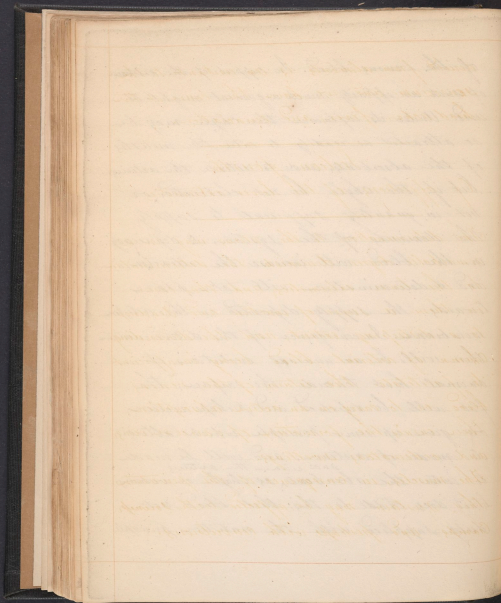
Dispepsia and constipation are the direct
~~consequences~~ ^{consequences} of the diminished action
of the alimentary canal. These are always in
a greater or less degree according to the par-
ticular circumstances of the case. Directly
resulting from them are, an accumulation
of crudities on the stomach, Cardialgia, nausea,
and vomiting. Now these last, may irritate
the stomach so much as to increase
the determination to that organ and
thus excite its healthy action. But if
they have not this effect, then there is
necessarily a suspension in the usual mode
of supplying the system with the princi-
ple of nourishment derived from aliments,
as the chyle cannot in this case be elaborated.
If the dispepsia were complete death must
speedily ensue, unless there were some other



source whence the demand of the system might be supplied; for as vital action is supported by the nutritive principles, if those principles can be no longer acquired vital action must cease. The adipose deposition in the cellular texture is the principle source whence a supply may be obtained by which vital action may in so extreme a case receive temporary support. According to the activity of vital action will be the rapidity with which this source of supply is exhausted. This supply is taken into the circulation by absorption, which, it has now become necessary for me briefly to explain.

In entering upon this explanation I must lay down the proposition, that, between the nutritive principle derived from atmospheric air and that derived from aliment there exists a strong and peculiar affinity analogous to that which influences the return

of the venous blood. In support of the existence
of such an affinity much argument might be
used. Under its influence the chyle may be
so attracted as readily to enter the mouths
of the absorbents, and to retrace the arteries;
but if the chyle be not elaborated, or
not in quantity sufficient to supply
the demands of the system, its deficiency
in the blood will increase the attraction,
and a determination will take place
towards the supply deposited in the adipose
membrane. In consequence of this determination
there will be an unusual evolution of
animal heat towards the surface; the
fat will be dissipated and perhaps receive
or give up some principle which alters
its mode of existence, and will be made
to enter the absorbents ^{and retrace the arteries} as chyle or venous
blood does. Add to this, that blood not
duly supplied with the nutritive principle

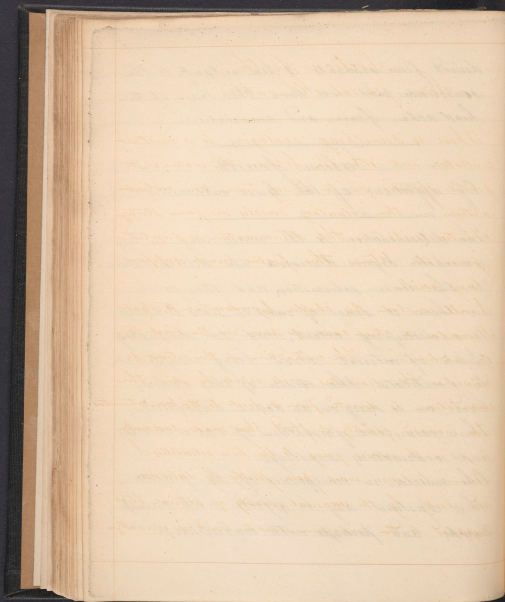


derived from aliments is an irritant to the
sensorium and we have the cause of the
head ache, fever, and emaciation.

Section fourth
Of affections of the lower extremities

The determination to the uterus may in a
remarkable degree diminish the determination
to the lower extremities, and thus cause
in them a sense of inaction and deadness
to a distressing extent, and the descending
column of arterial blood being insufficient
to facilitate the return of the venous
blood, or to carry on an active absorption,
there ensues the formation of varicose veins,
and oedematous swellings.

The muscles, in consequence of the privation
they sustain may be affected with soreness,
cramps, and perhaps with convulsions.



Section fifth

Some general observations

There is something analogous to a constant
contusion and struggle between the maternal &
foetal systems, and if at any time, from violent
action in the voluntary muscles or from strong
counter irritation the determination is diverted
from the uterus, the foetus must suffer
may perish.

I will conclude this chapter by adverting to what
I consider a chief cause of pain in the first stage
of parturition. The contraction of the uterus di-
minishes the diameter of its vessels, by which the
circulation is diverted from it, first to the lower extremities.
The increased quantity of fluid thus made suddenly
to pass in the arteries going to the lower extremities I
believe to cause much pain, partly by distension
and partly by the unusual quantity of arterial blood
supplied to the sensorium about the loins & hips especially.

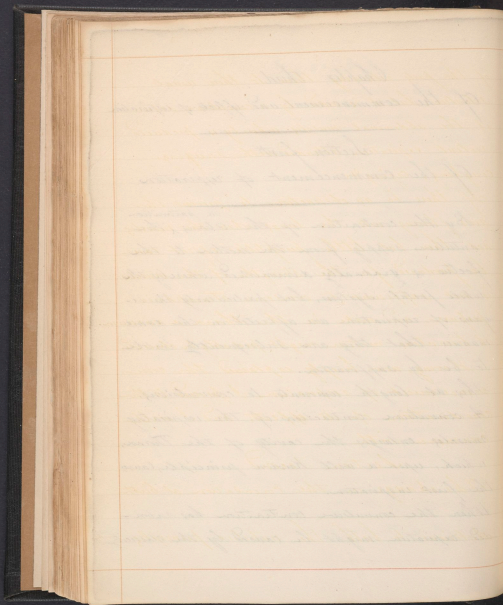
Chapter third Of the commencement and effects of respiration

Section first Of the commencement of respiration

By the contraction of the ^{in parturition} uterus, the nutritive supply from the mother to the foetus is gradually diminished, whereby the whole foetal system, but particularly the organs of respiration are affected in the same manner that they are subsequently liable to be by suffocation.

This at length amounts to convulsions. A convulsive contraction of the respiratory muscles enlarges the cavity of the Thorax, which, upon a well known principle, causes the first inspiration.

When the convulsive contraction has subsided expiration might be caused by the elasticity



of the parts returning them to their usual situation, but it is aided by a convulsive action of the abdominal muscles, whereby is produced violent expiration attended with sneezing, coughing, crying &c.

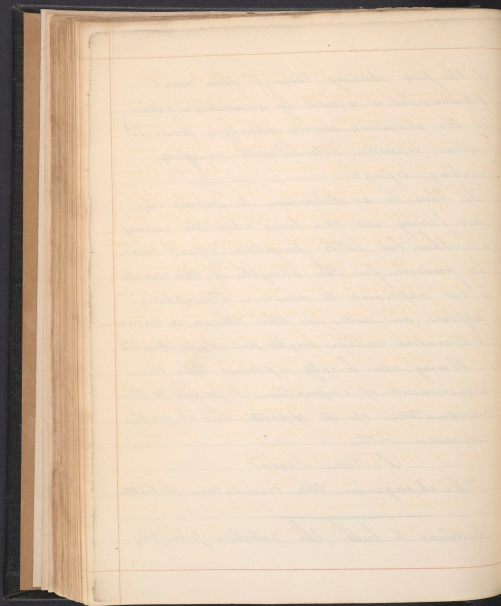
If there be an obstruction to prevent the air flowing into the lungs when the muscles act, then, but little perceptible effect can be produced, for the strength of the muscles is not sufficient to overcome atmospheric pressure, and make in the thorax a vacuum. A tremulous motion might probably be observed.

Having, now, briefly explained the commencement of respiration, I proceed to the consideration of its effects, and I will commence with

Section Second

The change in the circulation at birth

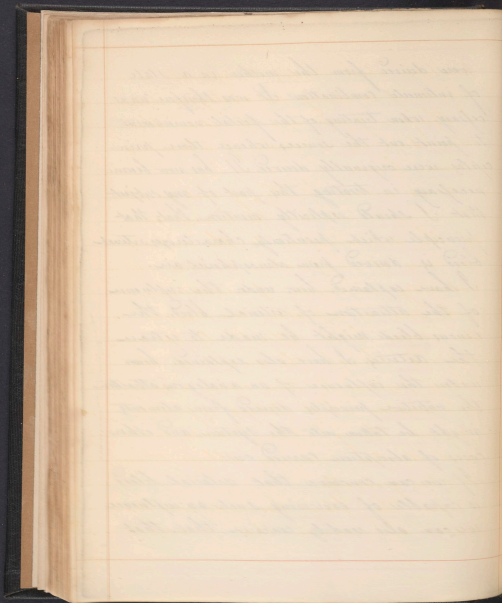
Anterior to birth the nutritive principles



were derived from the mother in a state of intimate combination. It was therefore unnecessary, when treating of the foetal nourishment to point out the sources whence those principles were originally derived. It has now become necessary in treating this part of my subject that I should explicitly mention, that, that principle which peculiarly characterizes arterial blood is derived from atmospheric air.

I have explained, how, under the influence of the attraction of arterial blood, the venous blood might be made to retrace the arteries. I have also explained, how, under the influence of an analogous attraction the nutritive principles derived from aliments might be taken into the system, and other cases of absorption carried on.

If we can conceive that arterial blood is capable of exercising such an influence we can also readily conceive, that, that



principle which renders it arterial is capable of exercising an analogous influence. I therefore proceed upon the idea that atmospheric air is capable of attracting venous blood.

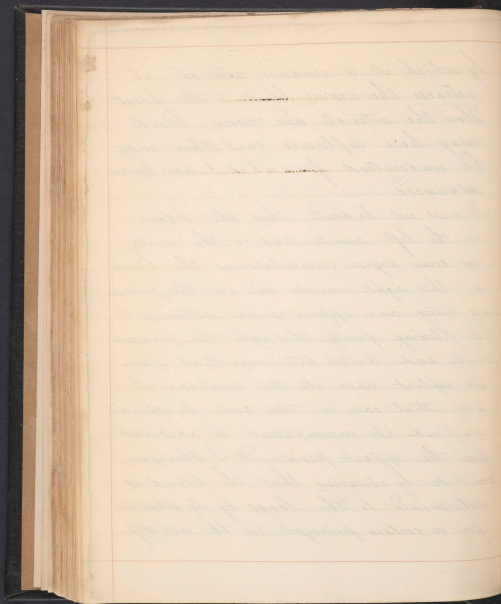
As an evidence of the ^{existence} of such an attraction I would introduce the circumstance of the determination to the surface in cases of suffocation, or even in voluntary suspension of respiration.

As soon as respiration commences, the venous blood, attracted by the air diffused through the air cells of the lungs, sustains to those organs a copious determination which taking off the pressure through the foramen ovale and ductus arteriosus allows them to close gradually.

When the blood has undergone that change and received that principle

by which it is rendered arterial it
retraces the venous blood to the heart X
How the arterial and venous blood
may here influence each other may
be understood from what I have before
advanced

It must not be denied that the blood
in the left auricle and in the aorta
in some degree counterbalances the blood
in the right auricle and in the pulmon-
ary artery and opposes some resistance to
its flowing freely through the foramen
ovale and ductus arteriosus; But when
we reflect upon all the mechanical
aid that can in this case be afforded
we find it incompetent to account
for the effect produced; I therefore
conclude by observing that the blood is
determined to the lungs by its attraction
for a certain principle in the air dif-



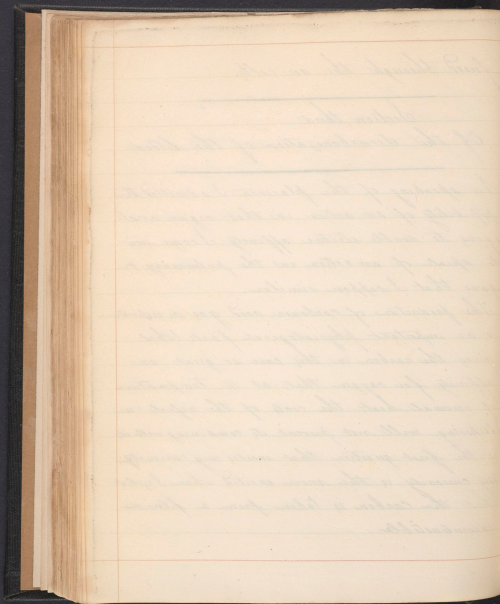
-fused through the air cells.

Section third

Of the decarbonization of the blood

In speaking of the placenta I admitted the possibility of an action in that organ analogous to double elective affinity; I come now to speak of an action in the pulmonary organs that I suppose similar.

The production of carbonic acid gas in respiration is an important physiological fact. What gives the carbon in this case so great an affinity for oxygen that, at the temperature of animal heat the coats of the vessels interfering will not prevent its combining with it is the first question that excites my curiosity; My curiosity is the more excited when I reflect that the carbon is taken from a fluid incombustible

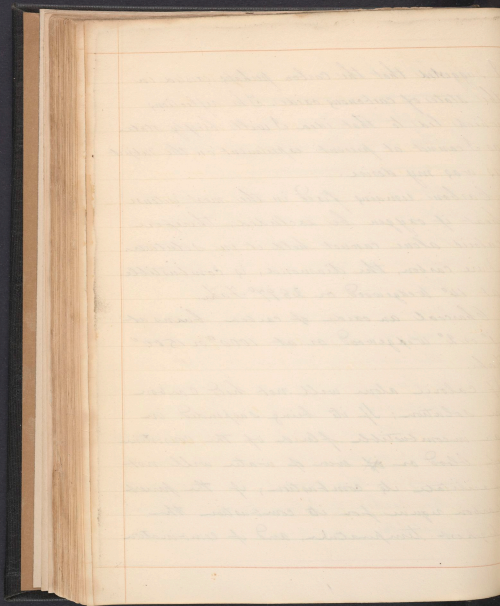


I suggested that the carbon perhaps existed in the states of carbonous oxide. The reflections which led to that idea I will briefly state as I cannot at present experiment on the subject as was my desire.

Carbon remains fixed in the most intense heat if oxygen be excluded; therefore caloric alone cannot hold it in solution. Pure carbon, the diamond, is combustible at 14° Wedgewood or 2897° Fahr.

Charcoal an oxide of carbon burns at 1° or 2° Wedgewood or at 1000° or 1500° Fahr.

If caloric alone will not hold carbon in solution; If its being suspended in an incombustible fluid of the consistency of blood or ~~or~~ even of water will not facilitate its combustion; if the purest carbon require for its combustion the highest temperature; and if combination



a portion of
with _x oxygen under more easy the combina-
tion with an additional portion; then I
infer that the combustion of pure carbon
does not take place in the lungs, but
that the carbon is combined with the
greatest portion of oxygen below saturation.

This must remain a subject for future investigations.
To suppose, in the foetus, the carbonous oxide to be
elaborated by the action of the sensorium on the
nutritive supply, and to be taken up by the blood at
the time it parts with its nutritive principles to the
sensorium; to suppose a similar exchange again to
take place in the placenta between the maternal
and foetal vessels; and again, an exchange not much
dissimilar, to take place in the lungs of the mother
in which the carbonous oxide (perhaps positively
electrified) unites with an additional portion
of oxygen and is expired, would not seem
wholly irrational.

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